SECONDS AFTER IMPACT: INSIGHTS FROM DIFFUSION BETWEEN LECHATELIERITE AND HOST GLASS IN TEKTITES AND EXPERIMENTS.

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Introduction: Tektites are natural glasses formed as a result of melting and quenching of distally ejected terrestrial material upon hypervelocity (>11 km/s) impact on Earth. Some tektites contain inclusions of lechatelierite (nearly pure SiO_2 glass; 99-100 wt. % SiO_2), generally thought to be the amorphous relicts of partially digested quartz grains [1]. This study exploits the presence of these local heterogeneities to extract information about tektite thermal histories by investigating chemical diffusion between molten silica inclusions and surrounding peraluminous felsic melt in natural tektites and experimental analogues.

Results: Concentration profiles across lechatelierite-host glass contacts in a natural tektite indicate diffusion between the two melts at high temperatures prior to quenching. Measured profiles of all oxide components are asymmetric in shape (indicating composition-dependent diffusion), and parts of these profiles indicate uphill diffusion of K_2O. We used the MELTS liquid activity-composition model [2] to convert composition to chemical potential, revealing that apparent uphill diffusion is primarily driven by non-ideal mixing in the melt.

We undertook a series of high temperature melting experiments using an aerodynamic levitation laser furnace. A starting mixture of powdered natural tektite was combined with ~10 wt. % 60-100 μm quartz grains and exposed to temperatures of 1800-2400˚C for between 1 and 120 s. Examination of the textures of the quench products of these experimental products suggest minimum times and temperatures for the formation of lechatelierite (i.e. complete melting of all quartz grains) of ~50 s at 2000 ˚C. Further, direct comparison of concentration profiles between the natural tektite and experimental charges reveals a 'best match' at 2200 ˚C and 50 s. This experiment successfully reproduced all major aspects of the concentration profiles from the natural sample including diffusion length scale, asymmetry, order of steepness of major elements, and uphill diffusion of K_2O.

Conclusions: The excellent agreement observed between experiment and natural sample provides a constraint on estimates of the thermal history of the tektite under investigation, as well as a way to check for internal consistency in our efforts to model diffusion between the two melts at high temperatures. These experiments and resulting diffusion model will lead to a better understanding of impact processes and the melt ejecta they produce.

References: [1] Koeberl C. 1994. *Geological Society of America Special Paper* 293:133-151. [2] Ghiorso M. S. and Sack R. O. 1995. *Contributions to Mineralogy and Petrology* 119: 197-212.